600/9-90/028

United States
Environmental Protection
Agency

Office of
Research and Development
Washington DC 20460

EPA/600/9-90/028
June 1990

EPA

Environmental Monitoring and Assessment Program

1990 Project Descriptors

EMAP

EP 1.23/6:

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June 1990

ENVIRONMENTAL MONITORING AND ASSESSMENT PROGRAM
1990 Project Descriptors

by

The Environmental Monitoring and Assessment Program
Office of Modeling, Monitoring Systems, and Quality Assurance
Washington, DC 20460

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OFFICE OF RESEARCH AND DEVELOPMENT
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WASHINGTON, DC 20460

PREFACE

The Environmental Monitoring and Assessment Program (EMAP) is a joint effort of the Office of Modeling, Monitoring Systems, and Quality Assurance and the Office of Environmental Processes and Effects Research, within the Office of Research and Development.

This document has been prepared to provide information on the projects within EMAP funded for Fiscal Year 1990. EMAP is an initiating program, and as such, most of its component projects are just beginning. Some projects will be implemented in 1990, while others will focus specifically on planning and strategy development for implementation within the next few years. As a result, descriptions of the projects contained in this document as well as lists of deliverables and milestones reflect current program plans, although it is likely that the details for some projects will change as EMAP plans progress and are refined. It is anticipated that this document will be updated annually to reflect current plans, following the closure of each fiscal year budget cycle.

For further information on any part of EMAP, contact the appropriate Project Officer or Principal Investigator noted on each project descriptor.

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SECTION 1
INTRODUCTION

The EPA, Congress, and private environmental organizations have long recognized the need to improve our ability to document the condition of our environment. Congressional hearings in 1984 on the National Environmental Monitoring Improvement Act concluded that, despite considerable expenditures on monitoring, federal agencies could assess neither the status of ecological resources nor the overall progress toward legally mandated goals of mitigating or preventing adverse ecological effects. In the past decade, articles and editorials in professional journals of the environmental sciences have repeatedly called for the collection of more relevant and comparable ecological data and for easy access to such data by the research community.

Affirming the existence of a major gap in our environmental data and recognizing the broad support for better environmental monitoring, the Science Advisory Board recommended in 1988 that EPA initiate a program that would monitor ecological status and trends and develop innovative methods for anticipating emerging problems before they reach crisis proportions. EPA was encouraged to become more active in ecological monitoring because its regulatory responsibilities require quantitative, scientific assessments of the complex effects of pollutants on ecosystems. Therefore, the EPA, in cooperation with other federal agencies, is developing the Environmental Monitoring and Assessment Program (EMAP).

Program Overview

EMAP is being designed to monitor indicators of the condition of our Nation's ecological resources. Specifically, EMAP is intended to respond to the growing demand for information characterizing the condition of our environment and the type and location of changes in our environment. Simultaneous monitoring of pollutants and environmental changes will allow the identification of likely causes of adverse changes. When fully implemented, EMAP will address the following questions:

- What is the current extent of our ecological resources (e.g., estuaries, lakes, forests, and wetlands), and how are they distributed geographically?
- What percentages of the resources appear to be adversely affected by pollutants and other man-induced environmental stress, and in which regions are the problems most severe or widespread?
- Which resources are degrading, where, and at what rate?
- What are the relative patterns and magnitudes of the possible causes of adverse effects?
- Are adversely affected ecosystems improving overall in response to control and mitigation programs?

EMAP will provide the Administrator and the public with statistical data summaries and periodic integrated assessments on ecological status and trends.

The major activities in 1990 around which EMAP is being developed follow:

- *Indicator Evaluation and Testing* – evaluation and testing of indicators of ecological condition
- *Network Design* – design and evaluation of integrated, statistical monitoring networks and protocols for collecting status and trends data on indicators
- *Landscape Characterization* – nationwide characterization of ecological resources in areas within the EMAP sampling network to establish a baseline for monitoring and assessment
- *Near Coastal Demonstration Project* – implementation of regional-scale surveys to define the current status of our estuarine resources

Although these activities will eventually be established in all categories of ecosystems, the initial emphasis will be on testing and implementing the program in estuaries, forests, and inland surface waters, coordinating these activities with the National Oceanic and Atmospheric Administration, the USDA Forest Service, and the U.S. Geological Survey, respectively. Because precipitation and air quality are two important factors influencing ecosystems, EMAP also will contribute to the evaluation and maintenance of the multi-agency atmospheric deposition networks currently coordinated by the National Acid Precipitation Assessment Program (i.e., the National Trends Network/National Dry Deposition Network). These ecosystems and deposition networks offer immediate opportunities to demonstrate the EMAP approach.

EMAP also will contribute to the development of a research program in environmental statistics. This program will refine the statistical framework for the remaining types of ecosystems in preparation for full implementation of EMAP in 1995 and beyond. Relying heavily on expertise from academia and industry, this program will develop methods and approaches for (a) analyzing and interpreting spatial and temporal trends in indicators across regions, (b) incorporating and substituting historical data and data from ongoing monitoring programs into EMAP, (c) designing efficient total quality management programs for ecological monitoring efforts, and (d) diagnosing the possible causes of adverse conditions in ecosystems.

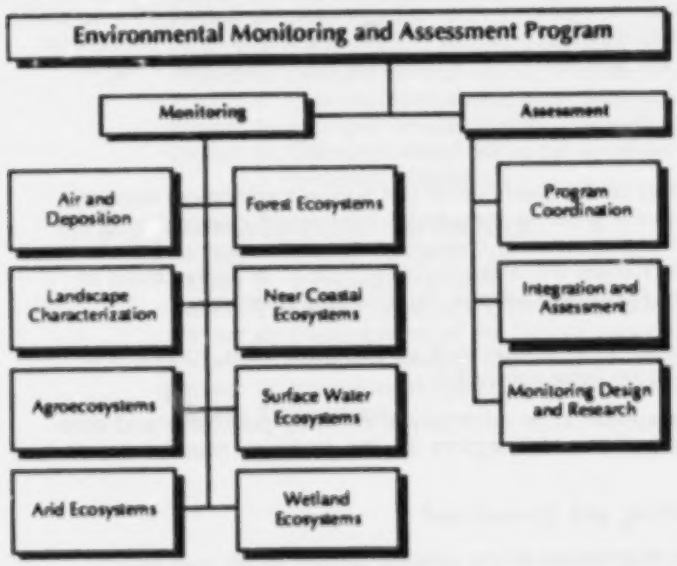

Figure 1. The EMAP components of monitoring and assessment activities.

This document presents summary descriptions of the major elements of EMAP. These project descriptors are organized into two categories: monitoring and assessment, the components of which are illustrated in Figure 1. The monitoring section addresses those projects associated with the planning and implementation of data collection activities. The assessment section describes projects associated with the analysis and interpretation of monitoring and ancillary data and the production of integrated regional assessments of ecosystem condition.

These project descriptors are intended to inform scientists and other interested parties, both within and external to EPA, about the current plans of EMAP. It is anticipated that this document will be updated annually.

Program Management

EMAP is a complex multi-disciplinary, matrix-managed program that requires a high degree of coordination among the various groups involved. To achieve this level of coordination, resources must be provided for several specialized tasks associated with program management. These tasks provide the EMAP Director and other program managers with the support necessary to

- hold planning meetings for developing long-term program objectives, setting Task Group resource targets, resolving management issues, and reviewing program plans and reports;
- prepare planning documents required by EPA senior management, Congress, and the Office of Management and Budget;

- support advisory committees to assist in the development and provide external review of program plans, strategies, and outputs; and

- develop and implement innovative techniques for managing large matrix-managed programs like EMAP.

EMAP has defined a program budget that reserves the necessary resources for these management activities as well as those resources associated with monitoring and assessment activities (Table 1). This management budget is essential to ensure facilitation of the program in 1990 as well as over the long term. The budgets for monitoring and assessment will be used to fund the projects described in the rest of this document.

Table 1. EMAP 1990 Budget Summary

Major EMAP Activity	R&D Funds ($1000s)	% Total
Program Management	1710.5	8.8
Monitoring	13447.9	69.4
Assessment	4230.8	21.8
TOTAL	19389.1	100.0

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MONITORING

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Monitoring

The monitoring aspects of the Environmental Monitoring and Assessment Program are targeted at addressing the first three questions listed in Section 1. EMAP will focus specifically on national and regional scales over periods of years to decades, collecting data on indicators of ecological condition from multiple ecosystems and integrating them to assess environmental change. This approach, along with a statistically based design, distinguishes it from most current monitoring efforts, which tend to be short-term or locally focused. A long-term, integrated, multi-ecosystem monitoring program offers the advantages of earlier detection of problems and improved resolution of their extent and magnitude, while enabling formulation of more cost-effective regulatory or remedial actions.

Environmental monitoring data are collected by EPA to meet the requirements of a variety of regulatory programs. Many federal agencies collect environmental data specifically for the purpose of managing particular ecological resources. Efficient execution of EPA's mandate to protect the Nation's ecosystems requires that EMAP complement, supplement, and integrate data and expertise from the regulatory offices within EPA and from other agencies. EMAP should not be perceived as a substitute for ongoing programs designed to meet objectives other than its own. Interagency coordination is actively being pursued with the Departments of Interior, Commerce, and Agriculture. This coordination avoids duplicative monitoring efforts, facilitates exchange of existing data for use in the refinement of monitoring networks, and increases the expertise available to quantify and understand observed status and trends. A joint program approach through the EMAP sampling concept/design also adds value to all existing programs. In addition, EMAP will draw upon the expertise and activities of the EPA Regional Offices, States, and the international community.

Ecological monitoring programs of the 1990s and beyond must be able to respond and adapt to new issues and perspectives within the context of a continuing effort to detect trends and patterns in environmental change. These demands will be met by EMAP through a flexible design that can accommodate as yet undefined questions and objectives as well as changing criteria of performance and scientific capability. Further, EMAP's design will encourage analysis, review, and reporting processes that foster discovery of unanticipated results and promote the widespread dissemination of scientifically sound information. Periodic evaluations of the program's direction and emphasis will be the key to maintaining its viability and relevance while retaining the continuity of the basic data sets. These evaluations will serve to preclude the "aging" that typically hinders long-term monitoring efforts.

A 1990 budget summary for EMAP monitoring follows.

1990 Budget Summary for Monitoring Activities

Major EMAP Activity	R&D Funds ($1000s)	% Total
Air and Deposition	574.2	3.0
Landscape Characterization	2420.7	12.5
Agroecosystems	344.5	1.8
Arid Ecosystems	273.4	1.4
Forest Ecosystems	1007.7	5.2
Near Coastal Ecosystems	6509.6	33.6
Surface Water Ecosystems	1968.6	10.2
Wetland Ecosystems	349.1	1.8
TOTAL	13447.9	69.4

Section 2.1: Air and Deposition

An important stress that has been linked to several adverse regional-scale changes in ecosystem condition is non-urban air pollution. These changes include the direct effects of poor air quality on forest and agricultural species, acidification of lakes and streams by wet and dry atmospheric deposition (e.g., acid rain), potentially reduced agricultural outputs due to stratospheric ozone depletion, and changes in agricultural patterns due to global climate change. Therefore, if EMAP is to interpret changes in ecosystem condition that may be associated with changes in air quality or deposition rates, it is important that data be collected and analyzed on these important stresses.

The specific objectives of the EMAP Air and Deposition Task Group follow:

- characterize in non-urban areas the regional status and trends of near-surface air concentrations and deposition,
- provide estimates of concentration/deposition for the development of empirical relationships between pollutant exposure and ecological condition indicators, and
- confirm the extent to which control program objectives are being achieved.

This effort will be implemented in stages. The first stage, which will begin in 1990, will identify and obtain existing data. Analysis of these data will define the best network configuration that can be developed around existing networks and the requirements of ecosystem researchers, policymakers, and the scientific community. These studies will contribute to the development of an air and deposition monitoring plan that will lay out the EMAP strategy for implementing these networks and for using and reporting the information obtained from them.

Project 1: Support for the National Dry Deposition Network

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Principal Investigator

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Period of Performance

1990-1992

Objectives

The National Dry Deposition Network (NDDN) is presently collecting data in support of the Acid Deposition Program. The NDDN is considered as the infrastructure on which to base EMAP air and deposition research in the future. This network is the only currently operating air concentration network that collects data from geographic areas of interest to EMAP. Network sites are located in non-urban areas. Data from this network are needed to estimate both spatial and temporal exposures to ecosystems in study regions.

Work Plan

Standard concentration monitors will be deployed at 51 sites throughout the United States to obtain concentration measurements using standardized procedures for collecting and analyzing dry deposition samples. Quality control audits will be performed to document the quality of the data collected and to improve network performance. The concentration data collected at these sites will be converted to dry deposition velocities using the Big Leaf Model, developed by the Deposition Monitoring Task Group of the National Acid Precipitation Assessment Program (NAPAP). This information will be reported in a form suitable for use by both EMAP and NAPAP. In addition to the field monitoring component of this effort, prototype concentration monitors will be deployed at certain research sites, and work will continue on developing sensors and samplers that will be used to refine NDDN protocols in the future.

Deliverables	***Time Frame***
• Annual data report and analysis for the National Dry Deposition Network	6/90

Project 2: Investigation of Existing Network Capabilities

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Principal Investigator

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Period of Performance

1990

Objectives

EMAP will rely, in part, on atmospheric exposure information from existing sampling networks, in particular the National Dry Deposition Network. Analyses must be performed to determine how well these existing monitoring systems characterize non-urban exposure. This information will be used to design a network that will provide data of known accuracy and precision in estimating spatial exposure and temporal trends.

Information from this project and the following one will be used by the ecosystem Task Groups to relate atmospheric exposure levels to ecosystem status. The information also will be used by policymakers who will implement new Clean Air Act Amendments to determine the effectiveness of emission reduction regulations.

Work Plan

Data from existing networks will be gathered and compiled into a data base. In addition to being used for this project, data will be available to other ecosystem Task Groups for their analysis. The data base will provide a central archive for atmospheric data collected in non-urban areas.

An advisory panel consisting of recognized experts in spatial statistics will be formed to provide advice and guidance to the Project Officer and Principal Investigator. This panel will meet regularly to review progress of the project.

Deliverables	***Time Frame***
• Report describing contents of non-urban atmospheric data base	8/90
• Report on existing deposition network capability	2/91
• Air and deposition monitoring and assessment plan for EMAP	2/91

Project 3: Study to Determine Optimum Status and Trends Network

Project Officer

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Period of Performance

1991-1992

Objectives

EMAP will rely, in part, on atmospheric exposure information from existing sampling networks, in particular the National Dry Deposition Network. Evaluation analyses from other projects will be used as a basis for supplementing existing networks with new and relocated sites. Enhanced networks will have the precision and accuracy required by ecosystem researchers to characterize non-urban exposure. Data collected by this network will provide data of known accuracy and precision for estimating spatial exposure and temporal trends.

This information will be used by EMAP Task Groups to relate atmospheric exposure levels to ecosystem status. The information will also be used by researchers and policymakers who will implement new Clean Air Act Amendments to determine the effectiveness of emission reduction regulations.

Work Plan

Analyses conducted for other projects will provide spatial variability estimates of pollutants of interest. These analyses will also indicate how well present systems characterize exposure to non-urban areas.

This information will be used to design an optimum spatial network. Analysis will indicate where additional sites are needed, where redundant sites occur, and where unusual situations (topographic features) require nontraditional methods for network design. The optimum spatial network will be supplemented, as needed, to ensure that required trends information can be obtained.

Deliverables	***Time Frame***
• Report describing an optimum "trends" network	6/90
• Report describing an optimum "status" network	4/91

Section 2.2: Landscape Characterization

Monitoring and assessment of status and trends in ecosystem condition must begin with a determination of the extent and distribution of ecosystems. The EMAP landscape characterization effort is designed to determine the extent and distribution of the Nation's ecological resources through the use of satellite imagery, aerial photography, and Geographic Information Systems (GIS). This information will provide a baseline against which results of EMAP ecosystem monitoring can be compared, i.e., it serves as a point of reference for status and trends monitoring.

Landscape characterization can also aid in the assessment of nominal or subnominal ecosystem condition. Because there is a strong correlation between landscape setting and ecosystem health or pollutant exposure, some types of spatial characterization data are directly applicable for use as stressor, exposure/habitat, or response indicators. For example, land use patterns should provide valuable information on the presence of stressors, and documented changes in the extent of ecosystem types (forests, agroecosystems, arid lands, etc.) should serve to indicate ecosystem response.

The long-term objectives of the the EMAP Characterization Task Group are to

- identify or develop land classification concepts appropriate to ecological monitoring information needs,
- apply these classification concepts in compiling regional and national baseline data in a geographic information system,
- identify and compile other categories of spatial data that can be incorporated into a national data base of the principal components of the landscape,
- generate a sampling frame for each target ecosystem,
- document nationwide extent and distribution of target ecosystem populations and subpopulations and other relevant landscape components for a base time period, and
- provide regional and national information of trends in landscape change.

During 1990, this effort will concentrate on the development of sampling frames for use in the design of ecosystem monitoring networks, the preparation of a Landscape Characterization Master Plan, and the initiation of landscape characterization pilot projects.

Project 1: Sampling Frame Development for Ecosystem Monitoring

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Period of Performance

1990-1992

Objectives

To develop an inventory of ecosystem classes (sampling frames for each ecosystem, excluding Near Coastal) on 12,600 hexagons for the purpose of selecting sites for field samples. Sampling frames will be developed for those ecosystems in which implementation will occur first, such as surface waters and forests in the New England states, with frames for other ecosystems to be developed at least six months prior to anticipated field sampling.

Work Plan

Sampling frame development will occur over a four-year period (FY90-FY93). See *Deliverables* for specific time frames by ecosystem. Sampling frames will be developed primarily from existing data sources such as the National Wetlands Inventory; some new imagery may be necessary, however, to determine the distribution of certain ecosystem classes. Imagery or existing data on ecosystem class distribution will be entered into a Geographic Information System (GIS); data from aerial photography will be interpreted and entered into the system, while other data already in digital format will be entered directly into the computer. Quality assurance procedures will be developed for each major step in completing sampling frames (e.g., measurement techniques and data base compilation). Samples can then be selected from the data base for each ecosystem class using assigned sampling rules (e.g., nearest discrete ecosystem unit to the center of the hexagon). Order and priority of developing sampling frames for ecosystems may change as a result of changes in program direction.

Deliverables	***Time Frame***
• The following time frames are anticipated for development of sampling frames and of GIS data bases and GIS-generated maps for ecosystem sample frames:	
Surface Water Ecosystems (national coverage)	FY90
Forest Ecosystems (Northeast)	FY90
Forest Ecosystems (national coverage)	FY91
Agroecosystems (national coverage)	FY91
Wetland Ecosystems (national coverage)	FY92
Arid Ecosystems (national coverage)	FY93

Project 2: EMAP Landscape Characterization Pilot

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Principal Investigator

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Period of Performance

1990-1991

Objectives

To pilot test a landscape characterization methodology, using satellite imagery (thematic mapper) and aerial photography, through the complete characterization of approximately 300 40-sq km hexagons. The information collected will allow the interpretation of landscape features that can then be used in EMAP monitoring, assessment, and planning activities.

Work Plan

The Landscape Characterization Pilot is made up of two major tasks. The first involves the collection and interpretation of thematic mapper (TM) data and aerial photography (both historical and new coverage) for a transect of 10 sites within the Virginian Biogeographic Province coastal watersheds. The TM and photography will be input in digital format in the Landscape Characterization Database (LCD), and a blend of photo and satellite sources on the same hexagons will be tested to determine the most cost-effective, multiple-source options to meet the needs of each ecosystem Task Group within EMAP.

The second major task is an effort to fully characterize approximately 280 40-sq km hexagons in New England. This task will be conducted in conjunction with the EMAP-Forest Ecosystem Task Group's Forest Monitoring Projects in New England, which will be implemented in the same region. Aerial and TM imagery will be acquired for an area in New England, to be defined by the Task Group. The imagery will be interpreted and placed into the LCD in digital format. Analysis and interpretation of data will provide an assessment of landscape conditions within the pilot area.

Deliverables	***Time Frame***
• Project report on characterization evaluation in the Virginian Province watersheds	7/90
• Journal article on characterization evaluation in the Virginian Province watersheds	11/90
• Project report assessing and interpreting landscape characteristics within the New England area (potentially joint report with the Forest Ecosystem Task Group)	4/91
• Journal article on landscape characteristics and status within the New England area	8/91

Project 3: Development of a Master Plan for Landscape Characterization

Project Officer

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Period of Performance

1990

Objectives

To develop a master plan for completing national characterization (12,600 hexagons) over a six-year period and to provide a framework for periodic re-characterization (approximately every 10 years). This plan will include strategies for using aerial and satellite imagery to establish a baseline for landscape characteristics across the United States. It will also serve as the initial step in detecting changes in landscape characteristics over time, including distribution and arrangement of ecosystem classes and land uses. These data, coupled with field data on individual ecosystems, will help determine patterns between ecosystem condition and changes in land use. The plan will also establish quality assurance requirements, data acquisition and collection schedules, and guidance for production of assessments and reports.

Work Plan

Characterization requirements for all the field monitoring components of EMAP will be finalized in early 1990. This process will be followed by a characterization assessment and reporting workshop involving experts in spatial statistics and landscape ecology. Using the results of this workshop, a draft master plan will be prepared and extensively reviewed, with a formal peer review to be held in mid-1990. Comments and recommendations from this peer review will be reconciled in a final manuscript.

Deliverables	***Time Frame***
• Characterization assessment and reporting workshop	2/90
• Draft EMAP landscape characterization master plan	3/90
• Final EMAP landscape characterization master plan	7/90
• Journal article: A multistaged approach to landscape characterization	10/90
• Journal article: Status and trends of ecosystems in the United States – a landscape approach	2/91

Section 2.3: Agroecosystems

Agroecosystems are highly stressed systems that are essential for human welfare, cover vast acreage, represent a leading sector of the U.S. economy, provide habitat for natural vegetation and wildlife, and serve as the largest source of non-point source pollutant loadings to streams and lakes in the United States. The goals of the EMAP Agroecosystem Task Group are to monitor the status and trends of the conditions in agroecosystems on a regional and national basis, to identify spatial and temporal patterns of the anthropogenic stresses impacting agroecosystems, and to attempt to assess the relative impacts of these stresses and natural stressors on agricultural resources. The specific objectives of the EMAP Agroecosystem Task Group are to

- determine the current condition of agroecosystems nationwide;
- understand the current pollutant levels/stressors associated with these systems;
- monitor the status/changes in agricultural resources and levels of stressors;
- determine the magnitude, rate, extent, and location of change in structure or ecosystem condition;
- identify possible cause for such changes; and
- identify specific agroecosystems that are at highest risk.

In 1990, the Agroecosystem Task Group will concentrate its efforts on planning and on evaluating data from currently operating monitoring networks in other agencies.

Project 1: Development of Monitoring Strategies for Agroecosystems

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Period of Performance

1990-1991

Objectives

To develop a master plan for national-scale monitoring of agroecosystems. No large-scale ecological monitoring plan currently exists for these ecosystems.

Work Plan

This project will be accomplished through the interaction and consensus of scientists from EPA and other agencies, universities, and institutes. Components of the master plan include a list of agroecosystem classes and indicators to be measured; a sampling design, including use of the National Agricultural Statistical Service (NASS) sampling network in EMAP; a total quality management plan; a logistics plan; a description of the relationship of EMAP-Agroecosystem sampling to EMAP-Characterization; and descriptions of assessment, data base management, and reporting activities. This plan will serve as the foundation for national-scale monitoring of agroecosystems within EMAP.

Deliverables	***Time Frame***
• Journal article on agroecosystem indicators	11/90
• Draft national monitoring plan for agroecosystems	11/90
• Peer review	1/91
• Final national monitoring plan for agroecosystems	4/91

Section 2.4: Arid Ecosystems

Deserts, grasslands, rangelands, and other arid and semi-arid lands are threatened by a variety of stressors, including loss of habitat, lack of sound water management practices, salinization, the invasion of non-indigenous plant species, land use, and non-point source pollution. The critical factors that determine the condition of arid ecosystems are water status and use, the physical and chemical integrity of the ecosystem, and the diversity of its plant and animal life. Developing and measuring indictors that can be used to quantify these factors on a regional basis is the goal of the EMAP Arid Ecosystem Task Group.

The long-term goal of arid ecosystem monitoring is to assess the extent and possible cause of regional problems associated with arid ecosystems. This goal will be achieved by establishing a multivariate index for indicators of arid ecosystem health and evaluating trends from early-warning indicators.

The first step toward this goal is the development of a national-scale monitoring strategy for arid ecosystems. This strategy will define procedures by which the EMAP Arid Ecosystem Task Group can develop indicators, sampling methodology, and classification schemes, and will identify the crucial issues that should be addressed in assessments of arid ecosystem condition.

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Period of Performance

1990-1991

Objectives

To develop a master plan for national-scale monitoring of arid ecosystems. This plan will address monitoring for deserts, grasslands, chaparral woodlands, prairies, and pinyon-juniper woodlands. No large-scale ecological monitoring plan currently exists for these ecosystems.

Work Plan

This project will be accomplished th ough a number of meetings and workshops involving scientists from EPA and other agencies, universities, and institutes. Components of the master plan include a list of arid ecosystem classes and indicators to be measured; a sampling design; a total quality management plan; a logistics plan; a description of the relationship of EMAP-Arid Ecosystem sampling to EMAP-Characterization; and descriptions of assessment, data base management, and reporting activities.

Deliverables	*Time Frame*
• Journal article on arid ecosystem indicators	11/90
• Draft national monitoring plan for arid ecosystems	11/90
• Peer review	1/91
• Final national monitoring plan for arid ecosystems	4/91

Section 2.5: Forest Ecosystems

Awareness of and concern for pollution damage to forest ecosystems have increased steadily over the past several decades. While our knowledge of the effects of specific pollutants on individual forest species has increased concurrently, the lack of consistent regional-scale monitoring data has hampered our ability to assess the health or condition of these important natural and commercial resources.

The EMAP Forest Ecosystem Task Group has been working closely with the USDA Forest Service in developing a joint approach for monitoring forest condition on a regional and national scale. As part of this process, the two agencies have translated the EMAP program objectives into a series of scientific questions. These questions will likely serve as the basis for the Task Group's planning and monitoring activities in the future.

1. What is the status and geographic distribution of forest productivity?

2. What is the status of potential stressors such as air pollution, climate, and land use?

3. What is the relationship between forest productivity and these stressors?

4. Which forests are declining in productivity, where are they located, and what is their rate of decrease in productivity?

5. What are the relative roles of air pollution, land use, and climate for the forests showing decreases in productivity?

Two major efforts are under way for EMAP forest monitoring in 1990. The first is a planning effort that will evaluate indicators of forest health and develop monitoring strategies that are consistent with the goals and overall design concepts of EMAP and the USDA Forest Service. The second consists of two projects involved with field data collection: (1) testing quality assurance and data management procedures on 206 sample sites in New England, and (2) evaluating and testing a full suite of indicators on 40 sample sites in New England and the southeastern United States. Both projects will be run jointly with the USDA Forest Service and appropriate agencies from the various states involved.

Project 1: Development of Monitoring Strategies for Forest Ecosystems

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Principal Investigator

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Period of Performance

1990

Objectives

To develop a master plan for a national forest health monitoring program that represents a joint effort between the USDA Forest Service and EPA. This plan will provide a comprehensive strategy for forest monitoring in the United States.

Work Plan

The USDA Forest Service (USDA-FS) and EPA will develop a joint national forest health monitoring program. This effort will be accomplished through a number of meetings and workshops involving EPA and USDA-FS scientists. An attempt will be made to accommodate the monitoring needs of both agencies. For example, it is likely that EMAP will use USDA-FS Forest Inventory and Analysis (FIA) sampling plots as its basis; selection of FIA sites is compatible with the proposed EMAP systematic grid. Several components of the plan will be developed by work groups consisting of scientists from both agencies. These components will include selection of a list of forest classes and indicators to be measured, a sampling design, a total quality management plan, a logistics plan, a description of the relationship of EMAP-Forests sampling to EMAP-Characterization, assessments, data base management, and reporting activities.

Deliverables	***Time Frame***
• Journal article on forest indicators	11/90
• Draft national monitoring plan for forest ecosystems	11/90
• Peer review	1/91
• Final national monitoring plan for forest ecosystems	4/91

Project 2: Field Evaluations of Quality Assurance and Data Base Management Procedures and Indicators

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Principal Investigator

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Period of Performance

1990-1992

Objectives

To determine effectiveness of and to refine quality assurance and data base management procedures that will be implemented in full-scale field monitoring in 1991, and to test and evaluate a full suite of forest indicators. Field tests of indicators will help refine methods and interpretive techniques needed for full-scale monitoring anticipated in New England and the southeastern United States.

Work Plan

In 1990, the EMAP Forest Ecosystem Task Group, in cooperation with the USDA Forest Service and State governments, will develop a single forest ecosystem monitoring plan for the northeastern United States. This plan will be implemented after extensive internal reviews by both Agencies as well as external peer review. The Forest Ecosystem Task Group will assume responsibility for (1) implementation plans and procedures, (2) quality assurance and quality control, (3) data collection and laboratory analyses, and (4) data analysis and reporting. The field efforts associated with the project will mainly be undertaken by the USDA Forest Service in association with their Forest Inventory and Analysis (FIA) program. The Task Group will evaluate the effectiveness of quality assurance and data base procedures. The Task Group will also develop an implementation plan to test and evaluate a full suite of forest indicators and then conduct prescribed field data collection of selected indicators. Approximately 20 sample sites will be selected in both New England and the southeastern United States. The Task Group will also evaluate existing data bases and utilize appropriate auxiliary data to supplement indicator data collected in the field. A detailed evaluation of these indicators will follow field data collection.

Deliverables	***Time Frame***
• Methods manuals for forest pilot project	5/90
• Logistics plan and training manual for forest pilot project	5/90
• Northeastern forest monitoring implementation plan	5/90
• Quality assurance plan for forest pilot project	5/90
• Indicator field evaluation plan for New England and the Southeast	6/90
• Data base management plan	6/90
• Report on results of indicator evaluation/tests	3/91
• Annual report on EMAP forest pilot project in the northeastern United States	8/91

Section 2.6: Near Coastal Ecosystems

The EMAP Near Coastal Ecosystem Task Group has placed its initial emphasis on estuaries. Estuaries were selected because they are important spawning and nursery grounds for many valued living resources, they receive a large proportion of the pollutants discharged into the Nation's waterways, and their natural circulation patterns tend to concentrate and retain pollutants. The focus of EMAP near coastal monitoring in 1990 will be a demonstration project in the Mid-Atlantic region. Information from this demonstration project will be used to refine the EMAP design, and the study itself will serve as a model for implementing EMAP projects in other study areas and types of ecosystems. The specific objectives of the Near Coastal Demonstration Project are to

- evaluate the utility, sensitivity, and applicability of the near coastal indicators on a regional scale;
- determine the effectiveness of the EMAP network design for quantifying the extent and magnitude of pollution problems in the near coastal environment;
- demonstrate the usefulness of results for planning, priority-setting, and determining the effectiveness of pollution control actions;
- develop standardized methods for measuring near coastal indicators that can be transferred to other study areas and made available to other monitoring and research efforts; and
- identify and resolve logistical issues associated with implementing the network design.

The strategy for accomplishing these tasks is to work closely with the National Oceanic and Atmospheric Administration's National Status and Trends Program to field test indicators and the network design in the estuaries of the Virginian Biogeographic Province.

Project 1: Development of a Near Coastal Monitoring Implementation Plan

Project Officer

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Principal Investigator

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Period of Performance

1990-1991

Objectives

To develop a research plan that describes the implementation of EMAP for near coastal ecosystems. The plan will be consistent with the overall objectives of EMAP, but will describe in detail how the regional implementation will proceed in near coastal ecosystems, starting with the estuaries in the Virginian Biogeographic Province (Cape Hatteras to Cape Cod) in FY90. The plan will be developed in concert with the National Oceanic and Atmospheric Administration (NOAA) National Status and Trends Program.

Work Plan

A draft research plan is being prepared that will detail how the program objectives of EMAP can be implemented on a regional basis for the estuaries of the conterminous United States. Several one-day workshops were held with scientists from academia and federal, regional, and state agencies to review indicators appropriate for implementation. A panel of recognized estuarine scientists will be convened to serve as a technical steering committee during the implementation of the Near Coastal Demonstration Project in the estuaries of the Virginian Province. This panel will initially peer review the research plan, then provide technical oversight as the information from the Demonstration Project is analyzed, assessments with the data are conducted, and national-scale implementation activities are recommended. Coordination of the Near Coastal Plan with NOAA will be handled through the EPA/NOAA Joint Committee for Coastal and Marine Environmental Quality Monitoring.

Deliverables	***Time Frame***
• Draft near coastal implementation plan	3/90
• Peer review of near coastal implementation plan	4/90
• Workshop to develop assessment strategies	9/90
• Draft final research plan for EMAP-Near Coastal monitoring and assessment program	9/90
• Recommendations for national-scale implementation of EMAP in estuaries	8/91

Project 2: Review and Development of Diagnostic Indicators for Marine Ecosystems

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Principal Investigator

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Period of Performance

1990-1992

Objectives

To develop a center for diagnosing marine fish diseases that will provide support for EPA research and regulatory programs. This center will conduct routine marine toxicological and histopathological tests and provide support for development of marine indicators to be used by the EMAP-Near Coastal Task Group.

Work Plan

A workshop was held in August 1989 to begin development of a strategy for marine bioindicator research. The draft strategy from this workshop will be used as a nucleus for developing a long-term marine indicator research strategy for EPA's Office of Research and Development. In concert with preparation of this long-term strategy, a proposal for the diagnostic center to support the near coastal monitoring efforts will be developed. Initial development of the diagnostic center will be through cooperative agreements with recognized institutions; eventually the center will acquire its own in-house expertise. Annual reports will be produced on the use of the diagnostic center in support of EMAP and other monitoring and research efforts within EPA.

Deliverables	***Time Frame***
• Review article on diagnostic indicators for marine ecosystems: physiology, biochemistry, and pathology	10/90
• Status report on the use of the fish diagnostic center in supporting EMAP Near Coastal	10/90
• Review article on bioindicators for marine systems: individuals, populations, and communities	10/91

Project 3: The Virginian Province Demonstration Project

Project Officer

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Period of Performance

1990-1992

Objectives

To address EMAP objectives by implementing a regional-scale demonstration project in the estuaries of the Virginian Biogeographic Province (Cape Hatteras to Cape Cod). As part of this demonstration project, the utility, sensitivity, and applicability of the EMAP-Near Coastal indicators will be evaluated on a regional scale; standardized methods for indicator measurements that can be transferred to other study areas and made available for other monitoring efforts will be developed; the effectiveness of the EMAP network design for quantifying the extent and magnitude of pollution problems in the near coastal environment will be determined; logistical issues associated with implementing the network design will be identified and potentially resolved; the usefulness of results for planning, priority-setting, and determining the effectiveness of pollution control actions will be demonstrated; and the value of the EMAP approach and regional-scale assessments will be demonstrated.

Work Plan

A draft implementation plan describing how to conduct a monitoring and assessment program that is consistent with the objectives of EMAP will be developed from a number of workshops and interagency discussions. Existing data and information from the Virginian Province will be used to select appropriate indicators; demonstration assessments will be performed with the selected indicators to ensure they are appropriate with respect to the overall program objectives. Development of the implementation plan will include other activities such as preparation of field and laboratory methods manuals, quality assurance plans and manuals, and logistics plans. These activities will be coordinated with other ongoing activities in EMAP to ensure program-level compatibility. An operational data management system will be developed, reviewed, and implemented. After all of the plans associated with the demonstration project have been reviewed and approved, the field component will be initiated.

The deployment of continuously recording dissolved oxygen instrumentation packages will be initiated in June 1990, followed by fish trawl surveys, water column sampling, and benthic grab sampling in July, August, and September. The instrumentation packages will be retrieved in September 1990. A preliminary report on the results of the demonstration project will be ready for review in February 1991, and a final report will be delivered in June 1991.

Deliverables	***Time Frame***
• Interim sampling plan for the Near Coastal Demonstration Project	3/90
• Logistics plan for the Near Coastal Demonstration Project	4/90
• Methods manuals for the Near Coastal Demonstration Project	4/90
• Quality assurance plan for the Near Coastal Demonstration Project	4/90
• Implementation plan for the Near Coastal Demonstration Project	6/90
• Data management system for the Near Coastal Demonstration Project	6/90
• Preliminary report on the Near Coastal Demonstration Project	2/91
• Final report on the Near Coastal Demonstration Project	6/91
• Initiation of routine monitoring in the Virginian Province	6/91

Project 4: The Louisianian Province Demonstration Project

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Principal Investigator

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Period of Performance

1990-1992

Objectives

To continue with the regional implementation plan in estuaries for Near Coastal by conducting a demonstration project in the Louisianian Biogeographic Province (Gulf of Mexico) in FY91.

Work Plan

Using the experience developed in the preparation of the research plan for the Near Coastal Demonstration Project in the Virginian Province, an implementation plan will be developed for the Louisianian Province. This plan will be consistent with the overall EMAP-Near Coastal objectives delineated in the Near Coastal Implementation Plan, but will incorporate province-specific needs and experience. The measurements taken during the Virginian Province monitoring activities will serve as a starting point for indicator selection. It is anticipated that a core suite of indicators will be common among the regions, but region-specific indicators may also need to be identified. The work conducted in the Near Coastal Demonstration Project in the Virginian Province for preparation of field and laboratory manuals, quality assurance plans and manuals, logistics plans, and data base management systems will enable the implementation in the Louisianian Province to proceed in an orderly fashion. Monitoring in the Gulf of Mexico will be initiated in FY91, with the first assessment report available in FY92.

Deliverables	***Time Frame***
• Draft program plan for the Louisianian Province Demonstration Project	10/90
• Implementation plan for the Louisianian Province Demonstration Project	2/91
• Final program plan for the Louisianian Province Demonstration Project	4/91
• Initiation of Louisianian Province field sampling	6/91
• Preliminary report on the Louisianian Province Demonstration Project	2/92
• Final report on the Louisianian Province Demonstration Project	6/92
• Initiation of routine monitoring in the Louisianian Province	6/92

Section 2.7: Surface Water Ecosystems

Lakes, rivers, and streams are important natural resources both from the human health and ecological perspectives. While there are many Federal, State, and local programs aimed at controlling pollutant inputs to these systems, currently there are insufficient data to ass ss the effectiveness of such programs in protecting biological integrity of surface waters. A lack of standardized methods and statistically based designs makes most current monitoring programs inadequate for quantitatively determining the status of these resources on regional scales or for detecting changes in that status. The EMAP Surface Water Ecosystem Task Group will attempt to fill this gap.

The primary goal of this Task Group is to provide unbiased estimates of the current ecological condition of lakes and streams and changes or trends in these conditions. This overall goal is supported by two specific objectives:

(1) to assess whether regulatory policies and programs aimed at maintaining water quality and biological integrity in aquatic systems are having the expected results on ecosystem condition on regional and national scales, and

(2) to provide limited diagnosis of likely causes of current conditions and changes in those conditions in lakes and streams.

The Surface Water Ecosystem Task Group is drawing on the experience resulting from EPA's involvement in the National Acid Precipitation Assessment Program (NAPAP); previously undertaken regional-scale surveys of surface water chemistry should provide a good basis for building a regional-scale monitoring network of the type needed in EMAP.

The Surface Water Ecosystem Task Group will undertake a planning and design effort to develop a strategy for a nationwide surface water monitoring program targeted at lakes and streams. As part of this planning effort, the Task Group will evaluate potential indicators, existing networks and data bases, and logistical and quality assurance approaches. The strategy will emphasize coordination of the EMAP surface water monitoring efforts with those in EPA and other Federal agencies.

Project 1: Assessment of Changes in Surface Water Chemistry

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Period of Performance

1990-1992

Objectives

This task is specifically designed to monitor the effects of acidic deposition on surface waters. It will provide regional assessments of patterns and trends in surface water chemistry in the low acid neutralizing capacity (ANC) systems of approximately 10 regions of the nation. A specific objective of this task is to assess the relationship between changes in regional acidic deposition and changes in regional surface water condition.

Work Plan

The foundation of the project will be a spatially extensive network of low ANC surface water sites (both lakes and streams), which are sampled annually for complete major ion chemistry, aluminum species, dissolved carbon, and several other variables likely to respond to changes in acidic deposition. Regions selected for monitoring will be those expected to experience changes in the amount of acidic deposition they receive, as a result of changes in the Clean Air Act (e.g., the Northeast), or those that will be unaffected by new regulations (e.g., the West). Information from these spatially extensive sites will be used to determine regional changes in acid-base status, which can be related to regional changes in sulfur, nitrogen, and base cation deposition.

In addition, the monitoring network will include in each region a small number of sites that are sampled more than once per year. These sites will be associated in a statistically rigorous manner with subpopulations of sites in the spatially extensive network. Data from these sites will be used to assess changes in surface waters in non-index periods (e.g., changes in the frequency and extent of spring acidic episodes) and to help interpret regional changes observed in the spatially extensive network. Regions will be prioritized to allow phased implementation of sampling at both types of sites.

Deliverables	***Time Frame***
• Plan for converting the NAPAP Aquatic Effects Long-Term Monitoring (LTM) program into Temporally Integrated Monitoring of Ecosystems (TIME)	6/90
• Statistical summary of long-term monitoring data (LTM data report)	10/90
• TIME first annual report (review draft)	10/92
• TIME first annual report (final draft)	3/93

Project 2: Indicators of Surface Water Condition

Project Officer

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Principal Investigator

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Period of Performance

1990-1992

Objectives

To develop a comprehensive strategy for using indicators of surface water condition; to define and implement a process for selecting a core set of currently available indicators of surface water condition; and to establish and implement a strategy for improving upon existing indicators and developing new indicators of surface water condition.

Work Plan

Producing an assessment of surface water condition requires a comprehensive strategy for selecting from the myriad of measurements that can be made and reducing these data into a concise statement about surface water condition. Endpoints that reflect societal and scientific concerns about surface water condition will be examined. A combination of biological, chemical, and physical measurements, analyses, and indices will be studied to address these concerns. Through the use of literature, existing data bases, and field tests, the EMAP-Surface Waters Task Group will develop an indicator strategy, evaluate the suitability of proposed indicators, determine expected spatial and temporal variability, develop regional modifications for selected indicators, and select the most appropriate criteria for establishing a healthy-unhealthy boundary for each indicator. A long-term program will include improving existing indicators, developing new indicators, and incorporating these indicators into EMAP. This work will be performed in coordination with aquatic scientists in other federal and state agencies.

Deliverables	***Time Frame***
• Journal article on regional use of index of biotic integrity (IBI) for water resource assessments	2/90
• Journal article on IBI modification	3/90
• Journal article on fish monitoring in acid-sensitive systems	3/90
• Status report on the evaluation of proposed indicators for surface waters	6/90
• Journal article on IBI trends	12/90
• Journal article on refinement of indices of lake health	1/91
• Journal article on conceptual basis of biological measures of health	6/91

Project 3: Design and Implementation of Surface Water Monitoring

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Period of Performance

1990-1992

Objectives

To design and plan the implementation of a national surface water status and trends program. A framework will be developed that will enable use of biological, chemical, and physical indicators to quantify the current regional and national ecological condition of lakes and streams as well as changes or trends in these conditions. A long-term monitoring program based on this design will be implemented and, in conjunction with the indicator strategy, will produce annual reports on the condition of surface waters and limited diagnosis of possible causes of current condition or changes in condition.

Work Plan

The Surface Water Task Group will evaluate the EMAP design in order to ensure that the objectives and approach for monitoring and assessment in surface waters are consistent with the overall program. Source materials for identifying lake and stream resources will be collected; rules for selecting lake and stream sample units and their inclusion probabilities, subpopulation classifications, and hexagon and watershed characterization requirements will be identified; and implementation guidelines will be developed. The rules and guidelines will be tested during a Lake Demonstration Pilot to be conducted in FY91; a Stream Demonstration Pilot is planned for FY93. Subsequently, annual surveys of a suite of biological, chemical, and physical indicators in these aquatic resources will provide data for estimates of national and regional conditions that will be reported annually. More in-depth interpretive reports will be produced on a regular but less frequent basis.

Deliverables	***Time Frame***
• EMAP strategy for surface water monitoring	7/90

Project 4: Logistics and Total Quality Management for Surface Water Ecosystems

Project Officer

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Principal Investigator

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Period of Performance

1990-1992

Objectives

To develop and implement the long-term logistics and total quality management approach for EMAP-Surface Waters.

Work Plan

EMAP-Surface Waters is a long-term, national monitoring effort. As such, it will monitor the biological, chemical, and physical condition of a statistically representative subset of the Nation's lakes and streams each year. This effort poses considerable logistical and quality assurance challenges. Sampling these systems in consistent and comparable manners across the country during a short index period each summer will be difficult. Working with federal, state, and private organizations, a comprehensive plan will be developed and implemented for gaining site access, coordinating field logistics, identifying field and laboratory procedures and analyses, training field crews, handling sample transport, and tracking, analyzing, and retrieving data. An extensive effort devoted to data quality assurance will begin with the development of data quality objectives, which are to be established prior to field implementation. Procedures for tracking the quality of data during its production at various locations (quality control) will be developed, refined, and implemented. The approach and statistical procedures for assessing data quality will be identified, developed, and implemented. Given the emphasis on biological indicators in EMAP, particular attention will be given to the control and assessment of the quality of quantitative and descriptive biological data. Total quality management will be an integral part of EMAP-Surface Waters. The concepts of quality control, assessment, and improvement will be extended from their applications in data quality to the entire program.

Deliverables	***Time Frame***
• Status report: Data quality objectives for surface waters	6/90
• Draft logistics plan	11/90
• Draft quality assurance plan for monitoring surface waters	11/90
• Draft pilot implementation plan for surface waters	11/90
• Final logistics plan for monitoring surface waters	3/91
• Final quality assurance plan for monitoring surface waters	3/91
• Final pilot implementation plan for surface waters	4/91

Section 2.8: Wetland Ecosystems

Wetlands are productive, diverse ecosystems that can be instrumental in improving water quality through the interception of sediments, pollution immobilization, and the limited uptake of various pollutants and nutrients carried in flowing waters. They also aid in flood storage and shoreline stabilization and are valuable habitat for waterfowl, commercial fisheries, and numerous endangered species.

The EMAP Wetland Ecosystem Task Group is currently working with the Department of Interior's National Wetlands Inventory and other wetland research programs within EPA to develop a statistically sound monitoring plan that meets the needs of both agencies. A series of meetings and workshops will result in the production of a "synthesis" document. This document will describe current approaches to determining the condition of wetland ecosystems, including the classification schemes and indicators used, and will propose a strategy for EMAP wetlands monitoring.

Project 1: Development of Monitoring Strategies for Wetland Ecosystems

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Period of Performance

1990-1992

Objectives

To develop a research plan for national-scale monitoring and assessment of wetland ecosystems. The stress, exposure, and response indicators, network design, and sampling strategy for wetlands will be finalized. Existing data sets will be analyzed to assess both (1) the sensitivity of various metrics for detecting known levels of stress and (2) the spatial and temporal variability of proposed wetland indicators of condition. Interagency coordination with the U.S. Fish and Wildlife Service's National Wetland Inventory will be pursued.

Work Plan

To meet short-term (FY90) objectives, EMAP-Wetlands will (1) develop an implementation plan and (2) evaluate proposed wetland indicators of condition using existing data. The EMAP-Wetlands implementation plan will be developed following consultation with U.S. Fish and Wildlife Service National Wetland Inventory personnel, EPA quality assurance personnel, logistics personnel, and data base management experts. The draft research plan will be peer reviewed and revised as necessary. The suitability of incorporating both existing wetland sampling networks and long-term monitoring sites into the EMAP frame will be evaluated. Accessibility of data and data quality of these sites also will be evaluated. In FY90 and 91, the sensitivity and spatial and temporal variation of proposed indicators will be evaluated using existing data sets. Association analyses, such as regression and cluster analyses, will be used when appropriate to evaluate indicator sensitivity to known levels of stress. Interagency coordination with the U.S. Fish and Wildlife Service's National Wetland Inventory will continue as each agency's role in EMAP-Wetlands is addressed and defined.

Deliverables	***Time Frame***
• Implementation strategy for monitoring wetland ecosystems	6/91

SECTION 3
ASSESSMENT

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Assessment

EMAP, like any effective monitoring program, must be able to translate the data it collects into forms that the public and other user communities can both understand and use. The reports expected to be produced by EMAP fall into two categories: (1) a series of Annual Statistical Summaries and (2) periodic Integrated Assessment Reports of ecological status and trends, that take into consideration user needs and requirements.

The statistical summaries are aimed at a broad audience, including interested government and non-government scientists, EPA senior management, environmental groups, the public, Congress, and the President. These summaries will not provide interpretations of the data, but will serve as a vehicle for routine dissemination of data and status and trends information. The assessment reports will be produced every four to five years and will attempt to identify relationships, both spatial and temporal, between data collected on trends in ecosystem condition and trends in stresses such as pollution. These reports will address questions concerning likely causes of adverse changes and the effectiveness of control and mitigation strategies. They will primarily be used by policymakers and resource managers within EPA and other agencies.

In order to produce these reports, EMAP has developed several centralized activities within the program to integrate, interpret, analyze, and report the data collected by the various EMAP monitoring efforts. This overall EMAP assessment approach is characterized by three distinct efforts: (1) program coordination, (2) integrated assessment, and (3) monitoring design and research.

A 1990 budget summary for EMAP assessment follows.

1990 Budget Summary for Assessment Activities

Major EMAP Activity	R&D Funds ($1000s)	% Total
Program Coordination	1556.3	8.0
Integration and Assessment	748.0	3.9
Monitoring Design and Research	1926.5	9.9
TOTAL	4230.8	21.8

Section 3.1: Program Coordination

The capability to integrate data and other information from a wide variety of sources is essential if EMAP is to produce its data summaries and integrated assessment reports. In order for this integration to be effective, a certain level of coordination across the program must be assured. Consistency in areas such as quality assurance, logistics (field operations), data and information management, and communications (technology transfer) is essential if EMAP is to efficiently assemble and disseminate information from a wide variety of monitoring activities.

The purpose of the Program Coordination projects is to ensure this consistency by providing guidance and support to the individuals responsible for planning, conducting, and reporting results from monitoring activities within EMAP. This support includes providing guidance for the development of individual monitoring implementation plans; reviewing those plans for consistency with EMAP, ORD, and Agency policies; and providing timely guidance on new policies and procedures that might impact or serve to improve EMAP monitoring operations. In 1990, most of these projects will concentrate on the development of plans and guidance documents to assist the ecosystem Task Groups in their planning and monitoring activities.

Project 1: Quality Assurance and Quality Control Program Planning for EMAP

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TBA

Period of Performance
1990

Objectives
The overall objective of the EMAP-Total Quality Management (TQM) Coordination Group is to provide guidance, support, and overview on quality assurance (QA) and control (QC) procedures and planning to the monitoring and assessment activities in EMAP. The initial phase of EMAP QA planning is the development of a Quality Assurance Program Plan that will provide a framework that the ecosystem Task Groups can use as they plan and implement the quality assurance aspects of their data collection and analysis activities.

Work Plan
The EMAP Quality Assurance Program Plan (QAPP) will be developed through a series of workshops and meetings and will be extensively reviewed both internally and externally. The QAPP is a policy document that will set the tone for QA activities within EMAP. This document will not only reflect EMAP's commitment to quality but will also provide specific mechanisms and policy guidance by which quality is to be maintained, quantified, and documented. Because EMAP is an interdisciplinary program of national scale, the QAPP will present an integrated strategy for guiding and coordinating QA activities across ecosystems, regions, and programmatic lines.

The QAPP will define policies and procedures for the development and use of program QA objectives, QA tools such as data quality objectives, and total quality management. This plan will be updated on a regular basis to integrate changes in program management, structure-specific objectives, and resources.

In addition to the development of the EMAP QAPP, the TQM Coordination Group will provide specific guidance and support to EMAP data collection and analysis activities. In 1990, the emphasis will be on support for the near coastal and forest demonstration projects and the landscape characterization effort. This will include assistance in developing and reviewing QA project plans and methods manuals for these activities.

Deliverables	***Time Frame***
• Environmental Monitoring and Assessment Quality Assurance Program Plan	7/90

Project 2: Logistics Program Planning for EMAP

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Period of Performance

1990-1992

Objectives

A coordinated approach toward field operations (logistics) will greatly enhance the effectiveness of data collection activities within the overall EMAP effort. Therefore, the long-term objective of the EMAP Logistics Coordination Group is to provide guidance and support to the ecosystem Task Groups for aspects of field operations and to enhance and economize EMAP field monitoring efforts through integrated team approaches.

Work Plan

The bulk of this project's activities in 1990 is associated with the development of an EMAP logistics overview and guidance document. This document will include standard formats, checklists, and review processes for use by the individual ecosystem Task Groups in the development of the logistics portions of their monitoring and implementation plans. The information in this document should enable a level of consistency to be maintained in the approaches used for logistics and should ensure that all the essential procedures are followed.

In addition to the logistics overview and guidance document, the EMAP Logistics Coordination Group will also develop several other key documents that will identify strategies for making effective use of personnel in conducting field sampling operations. One of these documents is an EMAP logistics proposal to the EPA Regional Offices. The Regional Offices are an integral part of EPA's overall field operations. Therefore, because EMAP is regional in scale, it is important that the regions be involved in planning and implementing EMAP monitoring activities. The EMAP logistics proposal to the EPA Regions will be the initial step toward regional involvement in EMAP field operations.

Deliverables	***Time Frame***
• Data base proprietary information strategy	3/90
• EMAP logistics overview and guidance document	7/90
• Six-year options and alternatives for EMAP logistics	8/90
• EMAP logistics proposal to EPA Regions	11/90

Project 3: EMAP Information Management

Project Officers

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Period of Performance

1990-1992

Objectives

To develop a comprehensive strategy and implementation plan for information management within EMAP; to provide support in the development of data base management systems for individual ecosystems; to perform a user needs analysis for EMAP data users; and to begin development of an information management system for EMAP.

Work Plan

An Information Management Committee consisting of members from the Environmental Monitoring Systems Laboratory-Las Vegas (EMSL-LV), Atmospheric Research Exposure and Assessment Laboratory-Research Triangle Park (AREAL-RTP), ERL-Corvallis, and the USDA Agricultural Research Service (USDA/ARS) has been formed to facilitate development of the plan and to provide guidance to individual ecosystem Task Groups. EMSL-LV will develop an overall strategy for information management. The plan will include sections on development of a central data base catalog, hardware and software requirements, data base standards, distributed network design, and GIS standards. With assistance from the Office of Information Resource Management, a user needs analysis will be performed to determine hardware, software, and network design needs. EMSL-LV and AREAL-RTP will develop and test a framework for a central catalog that will allow EMAP users to access specific data bases. The development of the EMAP information management system will be phased in over a five-year period, with early emphasis on supporting FY90 field sampling in forest and near coastal ecosystems.

Deliverables	***Time Frame***
• Geographic Information Systems conceptual plan	6/90
• Hardware/software systems needs (interim resources requirements plan)	10/90
• Initial information transfer guidance document	10/90
• Initial data catalogue/index system design plan	11/90
• Data base management standards (interim status report)	12/90
• Results of initial information transfer protocol tests	12/90
• EMAP information management plan	2/91

Project 4: EMAP International Activities: Regional Assessment of Pollution Sources and Effects in Nepal

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Period of Performance

1990-1991

Objectives

The overall goals of the EMAP international effort are to encourage the development of global-scale environmental monitoring networks and to initiate the extension of the EMAP concept on an international basis. This project represents an initial effort aimed at meeting these broad goals. The specific objectives of this project are to (1) establish a framework for water quality monitoring within Nepal, (2) provide a description of water quality at several "problem" sites, and (3) begin a species inventory of aquatic biota at several sites with differing water quality in an attempt to determine an index of water quality based on biological diversity.

Work Plan

The project planned is a joint effort among the EPA, Duke University, The Institute of Hydrology in the United Kingdom, and the Government of Nepal. A comprehensive water quality survey will be conducted on several catchments in Nepal. The focus of the survey will be those sites identified as "problem" areas in an initial survey scheduled for the summer of 1990.

Samples will be collected over a three- to four-week period, when streamflow is low and concentrations of many pollutants are expected to be maximal (autumn 1990 or spring 1991). These samples will be analyzed for heavy metals, major ions, and pesticides. Additional measurements will be made in the field, including concentrations of nitrate and dissolved oxygen, specific conductivity, pH, and temperature. Local scientists will be trained to take samples and operate field instruments to provide a basis for continuity of monitoring at selected sites, after this project is completed. At each sampling site, aquatic biota will be examined to establish the species diversity under differing water quality.

The chemical and biological data bases collected will be analyzed jointly with Nepalese scientists to establish (1) the relationships between biology and water quality, (2) the geographical distribution of water quality problems, and (3) a rationale for a representative network of sites to monitor pollution and ecosystem condition.

Deliverables	***Time Frame***
• Report on the relationship of water quality and the diversity of aquatic biota for selected sites in Nepal	12/91

Project 5: Technology Transfer

Project Officer

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Period of Performance

1990-1992

Objectives

EMAP will serve a wide spectrum of data users: the public, decisionmakers who require information to set environmental policy, program managers who must assign priorities to research and monitoring projects, scientists who desire a broader understanding of ecosystems, and managers and analysts who require an objective basis for evaluating the effectiveness of the Nation's environmental policies. Effective communication of program findings to these data users is critical to the usefulness of the program. In addition, the indicator strategies, methods manuals, and statistical concepts for the national/regional program should be prepared so that state governments and other decisionmakers can also use them to assess status and trends in subregional resources.

Work Plan

The first step in this project is to produce a communications strategy that outlines how EMAP can best inform states, regions, international organizations, and non-EPA officials of the benefits of EMAP and its potential usefulness to them. Such a strategy may include the use of brochures, videotapes, presentations at professional meetings, official briefings, and technical documents. It is critical that the strategy alleviate the potential problem of sending conflicting signals to states and other users regarding capabilities, opportunities for cooperative funding, potential burdens on monitoring staffs, and other issues that can result from multiple program contacts who are not fully cognizant of overall program plans and commitments. Technology transfer protocols must also be consistent with EPA's overall policy and procedures with respect to the states, other federal agencies, Congress, and foreign governments.

Deliverables	***Time Frame***
• EMAP Communication Strategy	6/90
• EMAP Management Strategy	6/90

Section 3.2: Integrated Assessment

Integrated assessment is an integral part of the overall EMAP assessment strategy and is the heart of the process that will produce the statistical summaries and integrated assessment reports. The objectives of these assessments are to

- integrate indicators of stress, exposure, and ecological response across ecosystems to determine the status of ecological resources;
- identify possible causes of poor, deteriorating, or improving conditions;
- detect trends across ecological resources on a regional scale;
- identify emerging problems and possible causes; and
- assess the relationships between regulatory/control programs and trends in ecological conditions.

A major component of integrated assessment is the integration function. Integration is the inclusion and synthesis of information on indicators of stress, exposure, and response within and among ecosystems and with monitoring data from other programs to determine relationships among these indicators. Integrated assessments use these data to answer policy-relevant questions that address specific problems of interest to EMAP clients and information users.

In 1990, the EMAP integrated assessment effort will develop the necessary tools and capabilities through a number of planning efforts and test these capabilities through a series of case studies and demonstration projects. These demonstrations will provide potential users of EMAP information with examples of the type of output EMAP can produce and will allow EMAP scientists to evaluate their integration and assessment strategies.

Project 1: Integration

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Period of Performance

1990-1992

Objectives

EMAP focuses on measurements of biological structure and function to assess the condition of ecosystems and on ambient measurements of pollutants and habitat degradation to indicate likely causes of poor or changing condition. Each ecosystem Task Group will need data collected by the Air and Deposition, Characterization, and other Task Groups as well as data collected outside the program to assess potential sources of stress to ecosystems. This project will examine the data needs of each ecosystem Task Group and how such data can be acquired most cost-effectively. Experience has shown that unless such needs are proactively identified and prioritized early in program planning, the needed data are subsequently found to be absent or insufficient.

Work Plan

In FY90, the Integration Coordination Group will (1) determine and assess what external data are needed by each ecosystem Task Group; (2) prioritize data needs so that activities can proceed in the most efficient manner for integration; (3) assist in evaluating alternative sources of data; and (4) evaluate and develop cost-effective alternatives for integrating field monitoring activities among ecosystem Task Groups. A matrix of the response, exposure, and habitat indicators will be prepared based on the indicator strategy lists. The indicators will be compared across Task Groups to determine whether common data needs among groups exist and whether dates and priorities for implementing monitoring activities differ. The matrix will be expanded to include data requested or provided by other agencies and data proposed to be measured outside the hexagon, and will be circulated among Task Groups (with areas of commonality highlighted) to facilitate Task Group interaction and to avoid redundancy. Similar matrices will be developed for field monitoring, data analysis, diagnostic procedures, and indicator development techniques to increase the cost efficiency of research projects. Data requirements for assessments to be prepared in later years by each Task Group will be identified from the example Integrated Assessment reports and will be updated as these reports are prepared and circulated among the Task Groups. As the program develops, the Integration and Assessment Coordinator will conduct specialty workshops on topics of joint interest among Task Groups to promote integration of approaches and data. As field data become available, exploratory analysis workshops will be conducted to identify potential inter-ecosystem relationships.

Deliverables	***Time Frame***
• Report on ecological indicators for determining condition in ecosystems	6/90
• Conceptual plan for EMAP	7/90
• Draft EMAP integration plan	9/90

Project 2: The Applicability of Indices to Ecological Status Assessments

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Period of Performance

1990

Objectives

Indices are mathematical aggregations of indicator values that are used to summarize information about ecosystem condition. Although indices, such as species diversity indices and the Index of Biotic Integrity, have been developed, indices of ecosystem condition are not widely available, nor can they be related directly to subnominal, marginal, or nominal ecological condition. The objective of this research is to define the necessary criteria for identifying suitable indices, potential approaches for formulating these indices, and candidate indices for further research.

Work Plan

Based on the indicators proposed by the ecosystem Task Groups for implementation or research, criteria for the development of suitable indices will be formulated and used to screen existing indices for applicability. Available indices then will be evaluated with respect to their ability to (1) accurately reflect poor ecosystem condition when it exists, (2) distinguish situations for which many indicators are only slightly below acceptable values from those for which only one or two are distinctly subnominal and (3) avoid false positives. The overall need for indices in a population-based approach also will be evaluated. Evaluation techniques are expected to include reviews of both case studies and statistical simulations using data collected by other investigators. Possible approaches for developing example indices will be formulated. A final report will be prepared that describes the characteristics of appropriate indices for EMAP, discusses the strengths and deficiencies of existing indices based on these criteria, and provides a list of potential candidates for further research. The final deliverable will be a journal article published in the peer-reviewed literature.

Deliverables	***Time Frame***
• Journal article on the applicability of indices to ecological status assessments	8/90

Project 3: EMAP Assessment Strategy

Project Officer

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Principal Investigator

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Period of Performance

1990

Objectives

The EMAP Assessment Strategy will provide a framework for (1) defining the types of policy-relevant questions that can be addressed by EMAP; (2) providing integrated assessment reports on status and trends in the condition of ecological resources; (3) identifying possible causes for poor, deteriorating, or improving conditions; (4) detecting emerging problems, their possible causes, and the potential risk to ecosystems; and (5) promoting the use of tools and information for assessing the relationships between regulatory and control programs and the reduction of risk to ecological systems. EMAP research and assessment activities will develop and refine techniques for identifying ecological hazards, assessing exposure, and characterizing risks to ecological resources.

Work Plan

A five-year EMAP Assessment Strategy will be formulated, focusing on seven areas: (1) defining the questions that can or cannot be addressed by EMAP; (2) formulating criteria to determine if the questions have been satisfactorily answered; (3) identifying critical data gaps; (4) evaluating existing diagnostic tools; (5) developing a protocol for conducting integrated ecological assessments; (6) identifying appropriate formats and displays for presenting EMAP results to decisionmakers and the public; and (7) presenting illustrative examples of how EMAP will assess current status and trends in the condition of the Nation's ecological resources.

The types of questions that can or cannot be defined by EMAP will be identified based on the EMAP network design and indicator documents and on questions identified by the individual ecosystem Task Groups as well as Headquarters personnel. Interactions with the Program Offices will be used to refine these questions. Data quality objectives (DQOs) will be established for each indicator, which will provide the criteria for users to determine if the resulting data will satisfactorily address their questions. Data gaps in existing networks will be compared across ecosystems to determine which data gaps are critical for integration among ecosystems and for development of associations among stress, exposure, and response indicators. Limitations in existing predictive and diagnostic techniques for identifying emerging problems and their potential causal factors also will be identified. These techniques will be evaluated and categorized as screening, empirical, and process-oriented techniques, and the most appropriate ones will be selected for refinement for application in EMAP. Finally, the strategy will focus on refining presentation and display procedures for assessment results. The concept of risk communication will be an integral part of this activity and, consistent with the ecological risk assessment theme, will strive to minimize the potential for misinterpretation and miscommunication of results. This Assessment Strategy will enable EMAP to provide the tools and data needed to improve ecological risk assessments.

Deliverables	***Time Frame***
• Draft EMAP assessment strategy	2/90
• Final assessment strategy	6/90

Project 4: Case Studies

Project Officer

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Period of Performance

1990

Objectives

EMAP will produce two types of reports, Annual Statistical Summary Reports and periodic Integrated Assessment Reports. The Annual Reports will describe the indicators monitored within EMAP and the data quality objectives (DQOs) that guide their measurement, as well as provide graphic displays of results with known levels of associated uncertainty. Initially, "mock ups" of the annual reports will be prepared as examples or "case studies" of the information that will be provided for each ecological resource when EMAP is fully implemented. These example Annual Statistical Summary Reports will inform potential users of EMAP data as to what will and will not be produced within EMAP and will aid in ensuring the ultimate design will meet users' needs. The objective of this project is to provide a guidance document to aid each Task Group in developing and preparing these example Annual Statistical Summary Reports.

Work Plan

Guidance, which will explain the purpose and format, will be prepared for each Task Group to ensure continuity, consistency, and comparability among the example Annual Statistical Summary Reports. The audience for these reports is anticipated to be Congressional staff members, the EPA Administrator, scientific administrators, and the informed lay public. The guidance will include how to prepare and present questions that EMAP will and will not answer (based on the EMAP goals and objectives, indicators being monitored by each Task Group, and the monitoring network design). Each Task Group will be asked to include in the reports the DQOs for the indicators proposed for monitoring, so that the users can decide whether the resolution proposed for these indicators will satisfy their needs. The guidance also will discuss the types of illustrative examples to include in the reports, such as frequency distributions, descriptive statistics, spatial displays and maps, indices, and associations among response and exposure/habitat indicators. An outline for the major sections of the Annual Statistical Summary Report will be included as part of the guidance.

Deliverables	***Time Frame***
• Guidance document for example Annual Statistical Summary Reports	2/90

Project 5: Near Coastal Model Integrated Assessment

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Period of Performance
1990

Objectives
The EMAP approach will be evaluated in a near coastal demonstration project in the Virginian Biogeographic Province in the summer of 1990. A model integrated assessment will show how EMAP data from the Virginian Province might be displayed and used to answer assessment questions related to the current status of estuaries or the relationships between watershed land use and estuarine conditions or atmospheric deposition estuarine conditions that point to likely causes for patterns or trends in regional estuarine condition.

Work Plan
A synthetic data set developed for dissolved oxygen patterns in the Chesapeake Bay and other large estuaries, along with a Monte Carlo sampling algorithm, will be used to refine the Near Coastal network sampling approach with respect to sampling frequency, duration, and temporal and spatial variability. This synthetic data set will be augmented with data on response indicators such as benthic species composition, exposure indicators such as sediment contaminant levels, and stress indicators such as land use and atmospheric deposition. The synthetic data set will be modified to reflect the distribution of system attributes ranging from small to large estuaries and the distribution of land use and deposition species throughout the Virginian Province. Existing data will be screened for indicator ranges, station locations, sampling frequency, period of record, and system types, and also will be used to augment the synthetic data set. The data set will be formulated to contain realistic associations among response indicators and among exposure and response indicators. Samples will be drawn from this data set using an interpenetrating frame. Association analyses such as regression and cluster analyses will be used to determine relationships among indicators and to test detectability of trends using different levels of spatial/temporal variability in the data. The synthetic data set also will be used to investigate the associations between watershed land use and nutrient loadings, nutrient loadings and response indicators, and watershed land use and response indicators. Relationships between atmospheric deposition response surfaces and the distribution of response indicators will be evaluated using pattern recognition analyses.

This information will be presented in the form of a model integrated assessment, which will emphasize presentation of the results – how these data can be displayed to show current status and trends in indicators of ecological condition. Distribution functions can be used to indicate the proportion of estuaries in the region with indicator values less than some criterion value; pie charts and stacked bar charts can be used to indicate the proportion of estuaries with values of response or exposure indicators in various categories; and spatial displays (e.g., maps)

can be used to identify patterns in stress, exposure, and response indicators with values in various categories. Trends in indicator values might be presented as changes in lower quartile or median values through time or changes in categories in stacked bar charts. This report will provide an example of the questions EMAP can and cannot answer, the presentation of data to decisionmakers, and potential refinements in the network design.

Deliverables	***Time Frame***
• Model Integrated Assessment for near coastal estuaries	8/90

Project 6: Example Annual Statistical Summary Report for Forest Ecosystems

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Period of Performance

1990

Objectives

The objective of this project is to produce an example of an Annual Statistical Summary Report for forest ecosystems. The intent is to use selected stress, exposure, and response indicators to illustrate how information on the condition of forested ecosystems will be presented annually to decisionmakers and the public. These example presentation formats will permit more effective communication between the Forest Task Group and the intended audiences.

Work Plan

Existing and synthetic data will be presented for selected stress, exposure, and response indicators in forest ecosystems. The report is being prepared to illustrate how forest condition indicators might be displayed and presented when the EMAP forest monitoring network is fully implemented. As such, it is intended only as an example of an annual statistical summary report. The example report will include descriptive statistics used to illustrate the landscape and regional scale patterns of forest ecosystem condition that can be obtained from the EMAP network design. These descriptive statistics will be presented as pie charts of forest condition (e.g., good, marginal, poor) for each major forest type in a region, spatial maps showing the geographic distribution of various condition indicators, histograms and line graphs showing the trend in forest condition indicators over time, cumulative frequency distributions showing the proportion of the forest resource as a function of the condition indicator, and other population-based presentation formats. The example report will indicate the types of questions EMAP has been designed to answer, how the data will be displayed in the annual report, and the general format of an Annual Statistical Summary Report. This example report will be used to initiate discussions with scientific administrators, policy analysts, and various public organizations on better techniques for displaying and presenting EMAP data.

Deliverables	***Time Frame***
• Final annual statistical summary example for forest ecosystems	6/90

Project 7: Example Annual Statistical Summary Report for Arid Ecosystems

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Period of Performance
1990

Objectives
The objective of this project is to produce an example of an Annual Statistical Summary Report for arid land ecosystems. The intent is to use selected stress, exposure, and response indicators to illustrate how information on the condition of arid land ecosystems will be presented annually to decisionmakers and the public. These example presentation formats will permit more effective communication between the Arid Ecosystem Task Group and the intended audiences.

Work Plan
A series of questions and issues relevant to arid ecosystems will be used to guide the design and develop an example of an Annual Statistical Summary Report on the condition of arid ecosystems. Examples for indicators of changes in land uses, changes in stressors, changes in exposure (e.g., air pollutant concentrations), and changes in ecological condition (functional and structural changes in ecosystems) will be presented. The report will be written for policymakers and the public. Existing data, data generated from characterization, and simulated data will be used to develop presentation and reporting techniques applicable at regional or biome scales, unless data are only available for smaller areas (e.g., vegetation associations). These presentation formats will include stacked bar charts showing the proportion of different types of arid lands in nominal, marginal, or subnominal categories for selected indicators; spatial maps showing the geographic distribution of indicators in these various categories; pie charts; time trends in indicators; and other techniques for displaying indicators of arid land condition.

Deliverables	***Time Frame***
• Final annual statistical summary example for arid ecosystems	9/90

Project 8: Example Annual Statistical Summary Report for Agroecosystems

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Period of Performance

1990

Objectives

The objective of this project is to produce an example of an Annual Statistical Summary Report for agroecosystems. The intent is to use selected stress, exposure, and response indicators to illustrate how information on the condition of agroecosystems will be presented annually to decisionmakers and the public. These example presentation formats will permit more effective communication between the Agroecosystem Task Group and the intended audiences.

Work Plan

A series of questions and issues identified for agroecosystems will be used to design and test a series of different presentation formats. The indicators currently being evaluated include selected crop yields (e.g., soybeans, wheat), pest density, land use classification, and soil erosion index. Relationships to ecosystem indicators will be discussed. The report will be written for policymakers and the public. Existing data, data generated from characterization, and simulated data will be used to develop presentation and reporting techniques. These reports will be made over regional or biome scales, unless data are only available for smaller areas (e.g., vegetation associations). Presentation formats will include both non-spatial (field measurements) and spatial (remote sensing and GIS) techniques, as well as reporting formats including spatial representation of all data (e.g., maps).

Deliverables	***Time Frame***
• Final annual statistical summary example for agroecosystems	9/90

Project 9: Example Annual Statistical Summary Report for Surface Water and Wetland Ecosystems

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Period of Performance
1990

Objectives
The objective of this project is to produce an example of an Annual Statistical Summary Report for surface water and wetland ecosystems. The intent is to use selected stress, exposure, and response indicators to illustrate how information on the condition of surface water and wetland ecosystems will be presented annually to decisionmakers and the public. These example presentation formats will permit effective communication between the Surface Water and Wetland Task Groups and the intended audiences.

Work Plan
The envisioned annual statistical summaries for EMAP Surface Waters and Wetlands will be presented using data on indicators from existing sources and simulated data sets. This illustrative report will include examples of data presentations for selected response, exposure, and stress indicators. Expected associations between indicators of ecological condition, land use, and other stressors will be displayed. Particular attention will be devoted to identifying the most appropriate levels of data aggregation, methods of presentation, and analytical tools to portray relationships between man-induced stresses and regional as well as national condition in wetlands, lakes, and streams. The data will be summarized and displayed in a manner consistent with the needs of policymakers and the public.

Deliverables	***Time Frame***
• Final annual statistical summary example for surface water and wetland ecosystems	6/90

Section 3.3: Monitoring Design and Research

There are a number of design and research projects, associated with both the monitoring and assessment activities, that are being undertaken by EMAP. These projects are aimed at improving our ability to collect, analyze, and interpret data and at developing new and innovative measures of ecosystem condition that can be incorporated into monitoring networks in the future.

The main emphasis of monitoring design activities is the development of a rigorous, integrated statistical monitoring framework for EMAP. This type of framework, which is essential if EMAP is to estimate status and trends in the condition of the Nation's ecosystems, will

- provide the basis for determining and reporting on ecological indicators at various geographic scales;
- be adaptable to monitoring on regional as well as on continental and global scales;
- enable the examination of correlations among spatial and temporal patterns of response, exposure, and stressor indicators;
- enable the incorporation or substitution of data from ongoing monitoring sites and networks; and
- be sufficiently adaptable and flexible to accommodate changes in the spatial extent of resources and to address current and emerging issues.

The research activities fall into two areas, spatial and temporal statistics and indicator development. The EMAP statistical research effort will develop new and innovative methods and approaches for

- analyzing and interpreting spatial and temporal trends across regions,
- incorporating and substituting historical data and data from ongoing monitoring networks,
- designing efficient quality assurance programs for ecological monitoring programs, and
- diagnosing the likely causes of adverse conditions in ecosystems.

Indicator development within EMAP will attempt to identify, evaluate, standardize, and use indicators that collectively describe the overall condition of an ecosystem and reflect characteristics clearly valued by society. Once an indicator or suite of indicators has been identified, it will be evaluated based on criteria such as the ability to distinguish between acceptable and unacceptable ecosystem condition or to represent adequately the exposure of an ecosystem to a significant level of stress. The three main types of activity associated with the EMAP indicator development effort are

(1) the development of a long-term indicator research strategy for all EMAP ecosystem types,

(2) workshops on ecological indicators, and

(3) reports evaluating the availability and applicability of indicators for all EMAP ecosystem types.

Project 1: Spatial Statistics

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Principal Investigator

TBA

Period of Performance

1990-1992

Objectives

The EMAP design is based on a systematic grid of triangular points arranged across the landscape. Observations at these grid points will be used to estimate characteristics of regional populations of ecological resources. Initial statistical efforts have focused on the regional population and temporal trends issues. This project will focus on the development of spatial statistical issues that will enhance the interpretation, reporting, and assessment of the EMAP information.

Work Plan

The primary task in FY90 will be to identify the spatial statistical issues that are relevant to the EMAP design and program objectives. A strategy will be developed that establishes the specific research requirements and priorities for addressing these issues. This strategy will identify the methods to be developed to incorporate spatial pattern information into population estimates generated from the EMAP sampling frame for improved estimation of ecosystem status. In addition, the landscape characterization efforts, stressor indicators, and multiple ecosystem monitoring will provide an extensive spatial data set that will be used in correlating status and trends among ecosystems as well as in diagnostics of their condition. The spatial pattern and model-based approaches to refining and improving those estimates will be addressed within the research strategy.

Deliverables	***Time Frame***
• Report on spatial analysis in EMAP: Issues related to design, analysis, reporting, and research needs	10/90
• Journal article on statistical graphics for applying geographic data to report ecological status and condition	11/90

Project 2: Temporal Statistics

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Period of Performance

1990-1992

Objectives

The most likely field sampling scheme for EMAP is one in which individual sites are visited once every four years. The group of sites sampled in one year will be distinct from the groups of sites sampled during the other years of the four years. Within a region, these groups of sites will conform to an "interpenetrating design," resulting in regional reporting on ecosystem condition within that region. The objective of this project is to explore the properties of this design using a rigorous statistical analysis to (1) devise methods for estimating trends in indicators from the series of population estimates derived from the four-year cycle; (2) assess, and adjust if necessary, the probable magnitude of effects introduced by sampling different groups of sites in each of the four years; (3) associate changes in temporal and spatial patterns in response indicators with explanatory variables and exposure and stress indicators; (4) evaluate the merits of alternative design options; (5) establish minimum detectability levels of trends, under various models for error variances; and (6) aid development of sampling plans by evaluating alternative sample sizes.

Work Plan

Several techniques for estimating trends, such as linear statistical models of trends, non-parametric trend tests, and conventional time series approaches (Auto-Regressive Moving Average [ARMA]), will be compared to techniques that are potentially more sensitive for trend detection. One such technique is an extension of the ARMA models that is structured to include the relationships between regression and time series methodologies; this technique specifically addresses items (2) and (3) above. A second approach will evaluate the Bayesian steady-state model to construct a test for a shift in the location parameter distribution. A third approach will evaluate the use of finite sampling methods to construct tests for trends. Extensive simulation trials will be conducted to investigate and assess the various models, estimation techniques, and design options with data sets constructed to reflect existing data set characteristics. The statistical power of the tests to detect trends will be established for data sets containing both linear and dynamic time trends.

Deliverables	***Time Frame***
• Technical report on simulation studies	3/90
• Report summarizing the use of an ARMA-based model for regional trend detection	5/90
• Journal article on simulation comparison of regional trend detection methods	6/90
• Journal article on mathematical derivations of ARMA, the trend model	7/90

Project 3: Development of the EMAP Sampling Grid

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Period of Performance

1990

Objectives

EMAP requires a sampling design that can sample any spatially distributed and identifiable ecological resource without having an explicit sampling frame. The design must result in probability samples for each resource, enable associations to be studied across resources, and be flexible and adaptive to accommodate many kinds of ecological resources of present and future interest. The design strategy required to meet these needs is a regular systematic point grid defined across the United States. These needs and design strategy lead to a set of criteria for the geometry of the grid: sampling unit selection areas that are equal, equal spacing of grid points, compact shape of areas associated with grid points, and a structure that enables enhancing and reducing the density of the grid. In addition, the system developed should allow EMAP expansion to non-conterminous parts of the United States and provide an interface to international monitoring efforts.

After investigating a number of approaches to this design problem, EMAP has adopted an adaptive approach that uses a map projection which produces a grid within a hexagonal region covering the conterminous United States, southern Canada, and northern Mexico. This hexagon is one of a series of hexagon and pentagon "plates" from a pattern that covers the globe. The pattern, called a tessellation, is that of the familiar soccer ball, technically known as a truncated icosahedron. In choosing to use an equal area grid from a map projection, the design must allow for some distortion in shapes and distances on the earth. The chosen map projection minimizes these distortions.

The objective of this project is to continue the design of this global sampling framework that provides planar projection surfaces with minimal distortion for subcontinental-sized areas on the earth and flexible configurations for optimal placement in arbitrary locations.

Work Plan

A number of technical tasks constitute the work plan for this project, including generation of the points for the North American grid, preparation of software code for the map projection, and development of algorithms for enhancing and reducing the density of the sample grid. In addition, two journal articles will be written: the first will describe alternative global tessellations, and the second will focus on cartographic and geometric considerations of the grid design.

Deliverables	***Time Frame***
• Journal article on cartographic and geometric components of a global sampling design for environmental monitoring	3/90
• Journal article on alternative global geometries	6/90

Project 4: Development of the Design Aspects of EMAP

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Period of Performance
1990-1992

Objectives
EMAP requires a rigorous, statistical, integrated monitoring framework as the basis for estimating and assessing ecological status and trends on a regional and national basis. The primary focus of this project is to design and evaluate the statistical monitoring framework, the protocols for collecting status and trends data, and the data analysis methods. Because new methods of data analysis are required for EMAP, statistical research will be conducted in several areas. Research will address the use of time series and other methods for assessing trends in populations and regional patterns, spatial statistics and the presentation of spatial patterns, protocols for using found data, statistical design for quality assurance, and sampling methodologies for representing conditions in large resources, e.g., Chesapeake Bay, Everglades, and Ohio River. Because of the increasing need for statisticians in environmental studies such as EMAP, a strategy for developing a training program in environmental statistics will be developed.

Work Plan
The basic EMAP statistical design has been developed. Initial efforts will be directed toward completing the technical documentation on design, analysis procedures, sampling schemes, reclassification, and aggregation procedures for reporting. An American Statistical Association panel will review the design in April 1990. Statisticians from academia, consulting firms, and other agencies will continue to provide statistical guidance on the EMAP design, data analysis, data base management, and quality assurance activities. As the ecosystem Task Groups and Coordination Groups develop their tasks and projects, workshops and interagency discussions will be held to address emerging statistical issues.

Deliverables	***Time Frame***
• Report on technical aspects of calibration in surveys	4/90
• Journal article on the use of found data and combination with probability samples	5/90
• Journal article on concepts and techniques for combining results of two probability samples	6/90
• EMAP network design report	6/90
• Report on application of calibration to survey data	7/90
• Incorporation of gauged stream data into a probability sample	8/90
• Research strategy for developing statistical methods for analysis and reporting of EMAP data: A five-year plan	10/90
• Strategy for creating a center for research and training in environmental statistics	3/91

Project 5: Research Strategy for Developing Indicators of Ecological Condition

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TBA

Period of Performance

1990

Objectives

The *Ecological Indicator Report for the Environmental Monitoring and Assessment Program* provides a conceptual framework for what is meant by ecosystem condition, what techniques might be used to measure it, and how such measurements can be used to suggest likely contributing factors to that condition. The objective of this project is to develop the research strategy required to improve the core set of indicators that will be implemented within EMAP.

Work Plan

The first task within this project will be to develop criteria regarding the status of indicators for applications within EMAP. We anticipate that indicator status falls into three categories: (1) available for implementation, (2) requires additional field testing and evaluation, and (3) requires research and development efforts. The indicators identified in the indicator report will be screened, evaluated, and categorized with these criteria. A fourth category is also anticipated: the current state of the science has not identified indicators of ecosystem condition, and development of conceptual models and identification of new indicators are required. The second task will be to identify and prioritize the existing indicator lists and the current and anticipated requirements for assessing ecosystem condition. The information developed in these tasks will form the basis of a five-year indicator research strategy for implementation by EMAP.

Deliverables	***Time Frame***
• Research strategy for developing indicators of ecological condition: A five-year plan	8/90

Project 6: International Symposium on Indicators of Ecological Condition

Project Officer

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Period of Performance

1990-1991

Objectives

An International Symposium on Ecological Indicators, sponsored by EPA and other agencies, will be held October 16-19, 1990, in Miami Beach, FL. The purpose of the symposium is to present state-of-science information on the identification, application, research, and monitoring of ecological indicators. The implementation of these indicators within a regional monitoring network and use of results to interpret environmental condition will also be discussed.

The development of appropriate indicators to describe and evaluate ecological status is crucial to improved information on the condition of the environment. EPA is currently evaluating indicators to be used in EMAP. The results of such a program will provide a broader understanding of ecosystems and research priorities, anticipate emerging environmental problems, and address national and international monitoring, regulatory, and policy needs. A key goal of the symposium is to convene international scientists, researchers, administrators, and policymakers who can contribute to a discussion of these issues.

Work Plan

The preliminary agenda includes plenary sessions on the first day that address the need for environmental monitoring and an overview of current programs, plus the development of ecological indicators and their use in monitoring and regulatory programs. The second day presents concurrent sessions on the development and application of indicators in specific systems: surface waters, forests, near coastal, wetlands, agroecosystems, and arid ecosystems. Presentations on the third day will address multiple scales (landscape, regional, and global) and uses and interpretations of indicator information. Plenary sessions on the final day will address present and future ecological monitoring, including future directions and priorities for ecological indicator research and implementation. Agency administrators, members of Congress, international environmentalists, and distinguished scientists are being invited as speakers.

Deliverables	***Time Frame***
• Proceedings of the international symposium on indicators of ecological condition	10/91

Project 7: Biodiversity

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Period of Performance

1990-1992

Objectives

To develop conceptual models and methodologies for biodiversity indicators, with emphasis on landscape-level indices for faunal (fish and wildlife) diversity and composition; to test the relationships between several landscape metrics and diversity, composition, and abundance, through analysis of existing data bases and literature; to evaluate the appropriateness of tested indicators for fulfilling EMAP objectives; and to provide implementation guidelines.

Work Plan

Research to fulfill the objectives will be conducted through a combined extramural and EPA research effort. The initial emphasis will be on developing and refining conceptual models for relating compositional biodiversity to landscape-level indices. This research will be based on thorough searches of literature and existing data bases for information on population and community response to measurable landscape patterns. Landscapes for further study and evaluation will be identified and prioritized, based primarily on the amount and quality of existing information.

Biodiversity in the northeastern United States will also be investigated. This effort will examine landscape cover pattern and diversity as well as bird diversity, and will evaluate statistical models for relating this information to indicators of regional biodiversity. Initial activities will focus on existing bird data bases for New England and will be coordinated with the EMAP Forest and Characterization efforts in this region.

Deliverables	***Time Frame***
• Annual report addressing conceptual models and literature reviews, synthesized New England biodiversity data bases, identification of gaps in existing data collection networks, and options for addressing data gaps	6/90
• Annual report plus journal articles on indicator validation, biodiversity monitoring, and New England results	6/91
• Annual report plus journal articles on conceptual models and indicators for monitoring and assessing landscape-level biodiversity, status report on biodiversity in the northeastern United States, and network design recommendations for implementation of regional biodiversity monitoring	6/92

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